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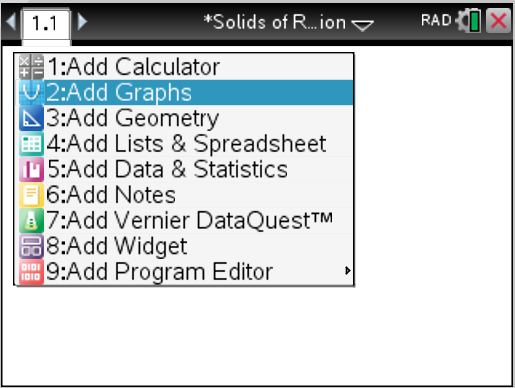
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<http://tinyurl.com/T3IC20173D>

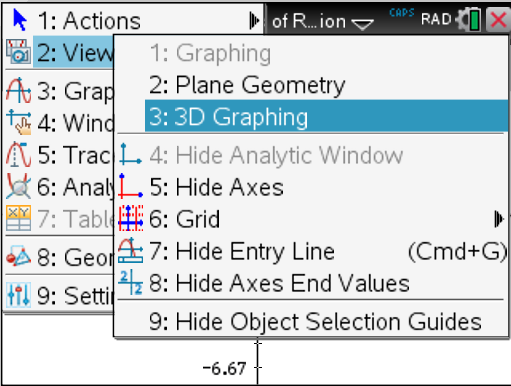
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# **1. Getting Started with 3D Graphing**

Create a NEW DOCUMENT (Home + 1) then select 2 to insert a GRAPHS PAGE.

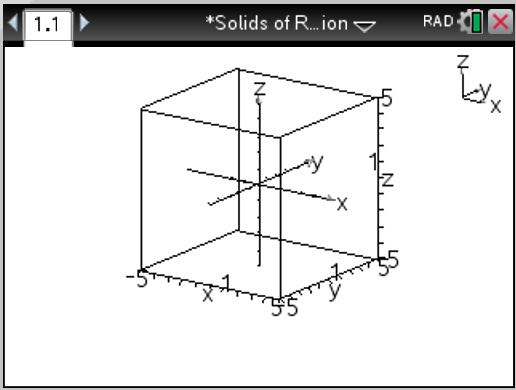


From the GRAPHS page, you want to CHANGE THE VIEW from 2D to 3D.  To do this, press MENU + 2 + 3



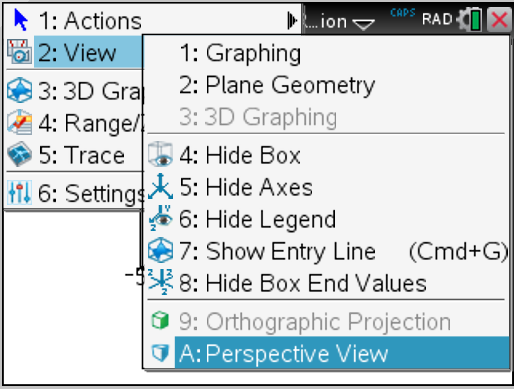
The default view is a 10 by 10 by 10 box.

Imagine the xy-plane on the table in front of you with the z-axis coming out of the table perpendicular to the table. This is the default view.

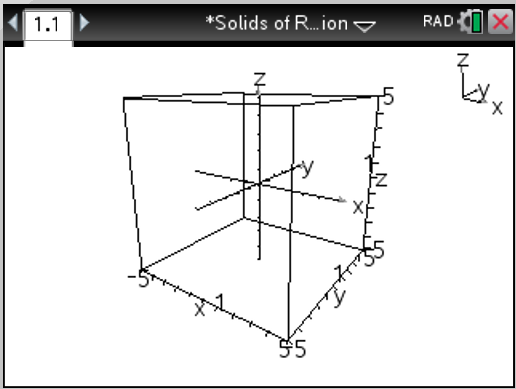


I really dislike this ORTHOGRAPHIC VIEW

Press **MENU + 2 + A** to change the view to PERSPECTIVE VIEW



That’s more like it!

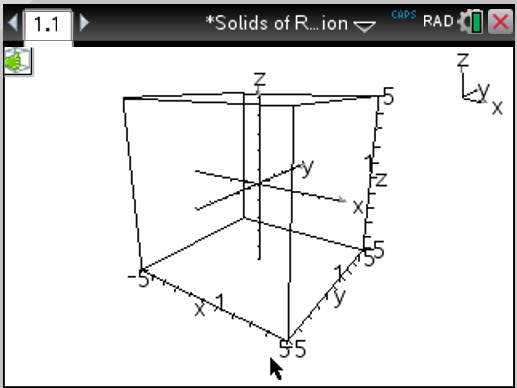


Once in the 3D view, there are some keyboard shortcuts that allow you to explore the view. Pressing **R** on the keypad allows you to **R**otate the view by dragging your finger along the touchpad or clicking the touchpad.

Try this.

Press the **ESC** (escape) button to turn this off.

(Notice the small hand-grabbing-and-turning-the-box icon in the upper left corner)

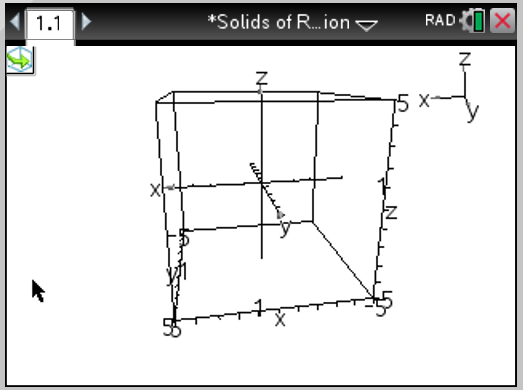


If that is too much work, pressing **A** on the keypad will rotate the view **A**utomatically!

Try this.

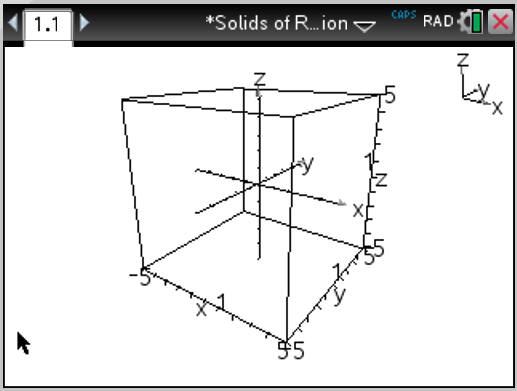
Press the ESC (escape) button to turn this off.

(Notice the icon in the upper left corner of the window)



Now that you have rotated your view, you can restore **O**rder by pressing **O** on the keypad and returning the axes to their **O**riginal **O**rientation.

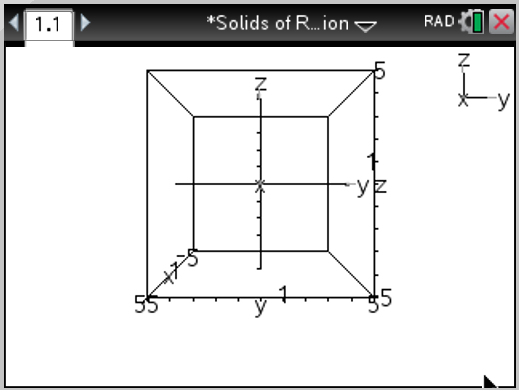
Try this.



To change your view in a systematic manner, pressing **X** will change your view to one looking down the positive **X** **axis**.

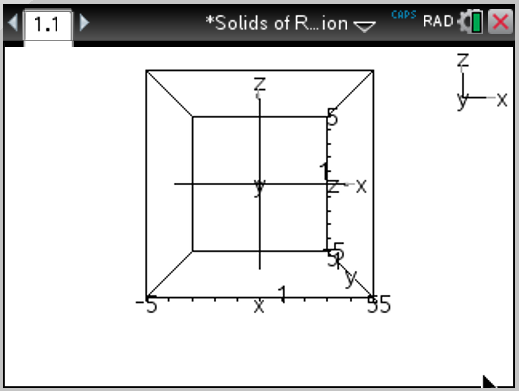
Try this.

Press **O** to restore the original orientation.



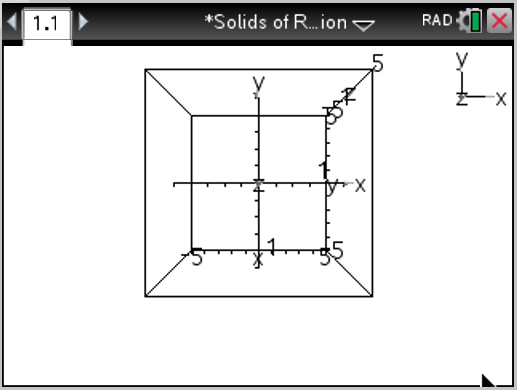
Pressing **Y** will change your view to one looking down the positive **Y axis**.   Try this.

Press **O** to restore the original orientation.

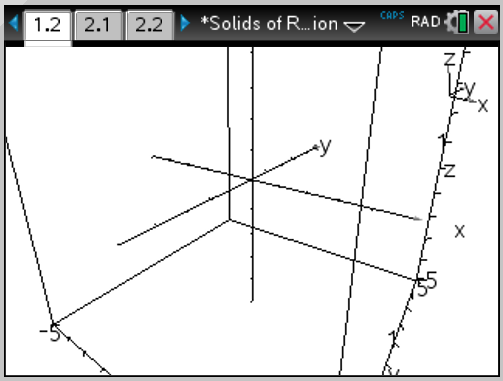


Pressing **Z** will change your view to one looking down the positive **Z axis**.   Try this.

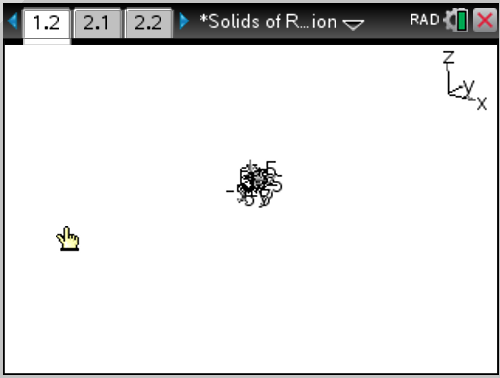
Press **O** to restore the original orientation.



If you would like to **ZOOM IN** to your graph, you can press the **x** (multiplication) button



To **ZOOM OUT**, press the button.

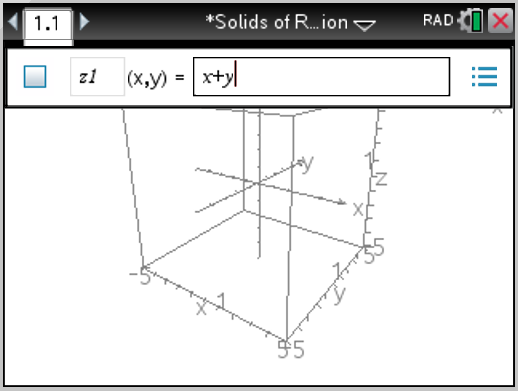


# **2. Cross Sections of a Cube.**

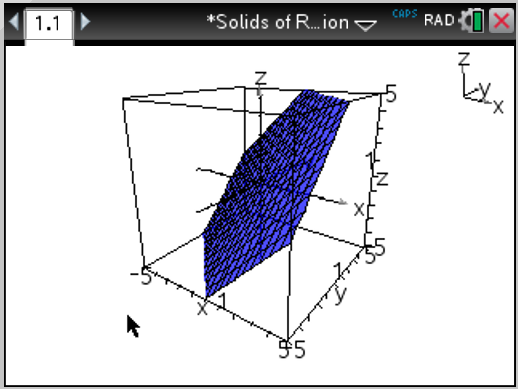
In the 3D graphing view, the default graphing mode is FUNCTION mode (just like in 2D).   Functions are of the form **z(x,y)**. Different x and y values lead to different z values.   Start by graphing **x+y** as shown below.

*If the Entry line is not visible, press* ***CTRL + G*** *to make it visible.*

Press ENTER to graph the function.



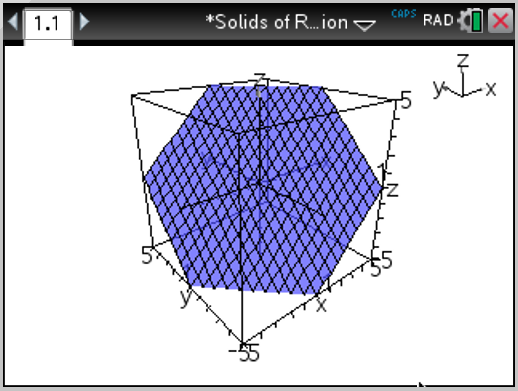
If you are in the default orientation, your screen should look like the figure at below.



If you are in the default orientation, your screen should look like the figure below.

Press **R** on the keypad and rotate the axes to a more favorable view.

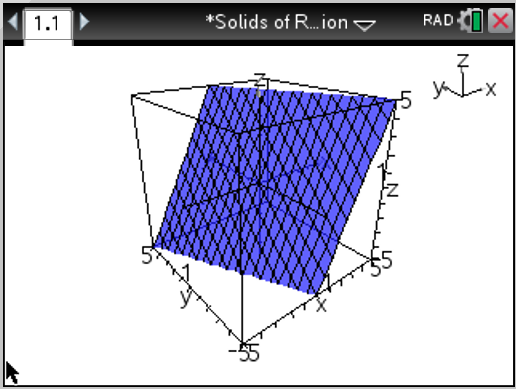
This is essentially the cross section of a 10 by 10 by 10 cube with the plane z=x+y.



* Press **CTRL+G** to get the graph entry line to appear.
* **Toggle UP** to get to the equation of the graph on the screen (z1).
* Modify the equation to graph **z=2x+y**.

How did the cross section change?

Looks like a rhombus. Could you prove it?



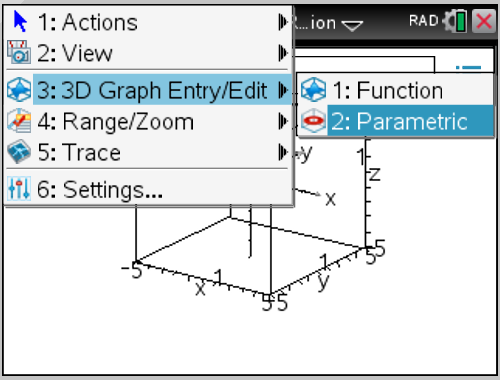
The are 11 typical non-trivial (point or a segment) cross sections of a cube that you can make by modifying your equation in this manner. Many of them can be done in more than one way. Try to create as many of these cross sections as possible, sharing your results with your colleagues.

|  |  |
| --- | --- |
| 1. Scalene Triangle 2. Isosceles Triangle 3. Equilateral Triangle 4. Trapezoid 5. Rectangle 6. Square | 1. Rhombus 2. Parallelogram 3. Pentagon 4. Hexagon 5. Regular Hexagon |

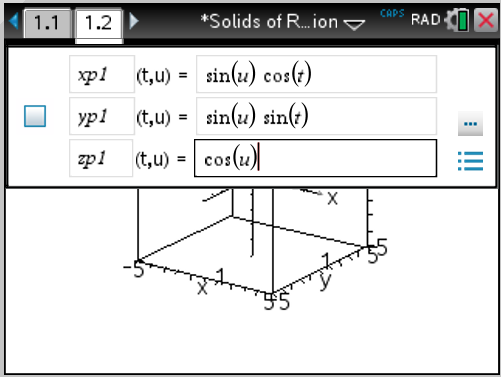
# **3. Making a Sphere.**

Add a new **GRAPHING PAGE (CTRL + DOC + 2)** and change the VIEW to **3D VIEW (MENU + 2 + 3).**

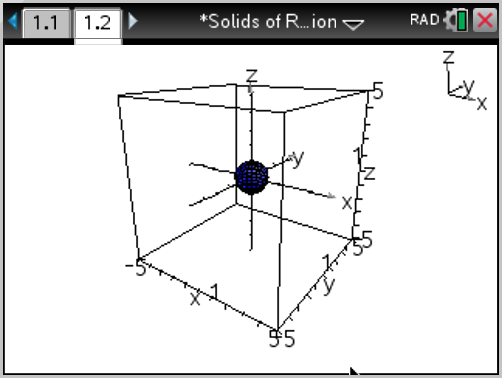
The easiest and CLEANEST way to make a sphere is to use PARAMETRIC MODE.  To switch into PARAMETRIC MODE, press MENU + 3 + 2.



Enter the equations shown below. The derivation of these equations can be found at the end of this document or in many places online.



Well...THAT is a small sphere.



The radius of this sphere is 1 unit. The general equation of a sphere in parametric mode has the form

x(t,u)=r sin(u) cos(t)

y(t,u)=r sin(u) sin(t)

z(t,u)=r cos(u)

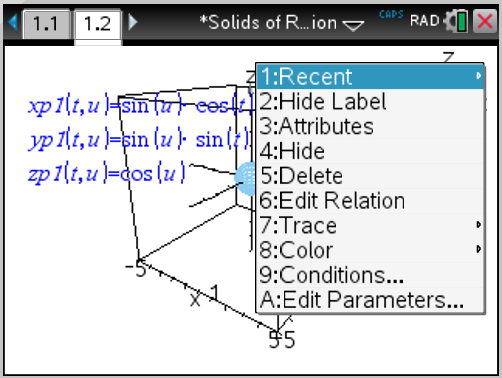
Where

r is the radius of the sphere

t is the longitude and varies from 0≤t≤2pi

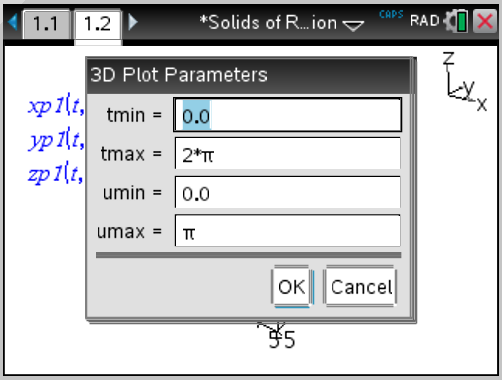
u is the latitude and varies from 0≤u≤pi

Let’s explore the parameter setting for the variables **u** and **t**. Click on the graph of the sphere so the “ghost” equation appears.   Then press **CTRL + MENU + A**.



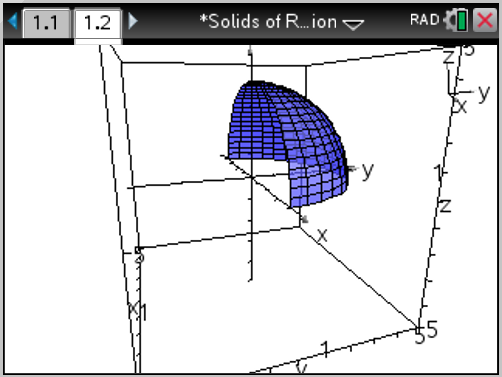
The default parameters are shown below.

* The variable t ranges from 0 to 2pi. The variable t controls the angle around the z- axis you turn.
* The variable u ranges from 0 to pi. The variable u controls your angle with the positive z-axis.



Edit the parametric equations you graphed to change the radius of your sphere to 4 units. Then, edit the parameters for your graph to complete the following graphing challenges:

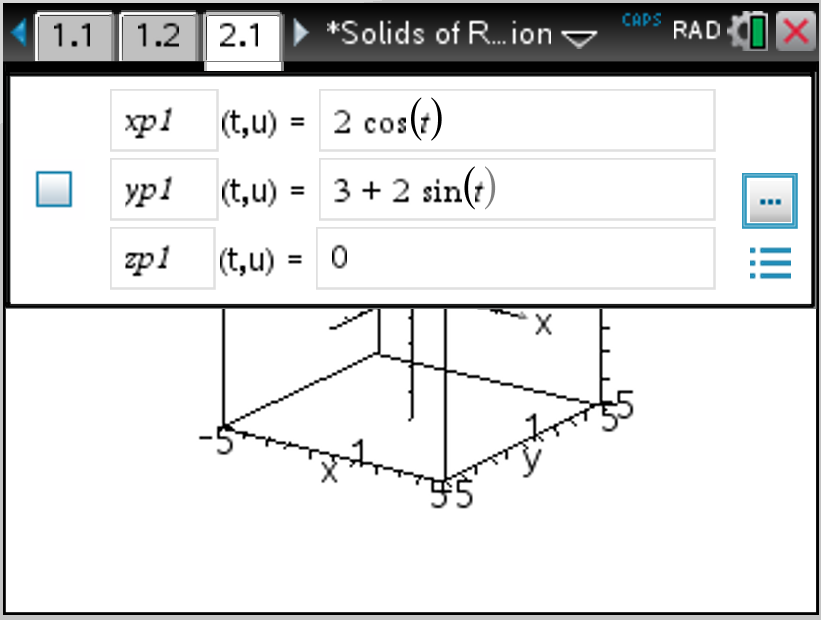
1. Graph the top half of the sphere (Northern Hemisphere).
2. Graph the “right side” of the sphere (Eastern or Western Hemisphere).
3. Graph an octant of the sphere.
4. Graph one-fourth of the sphere from the North pole to the South pole.



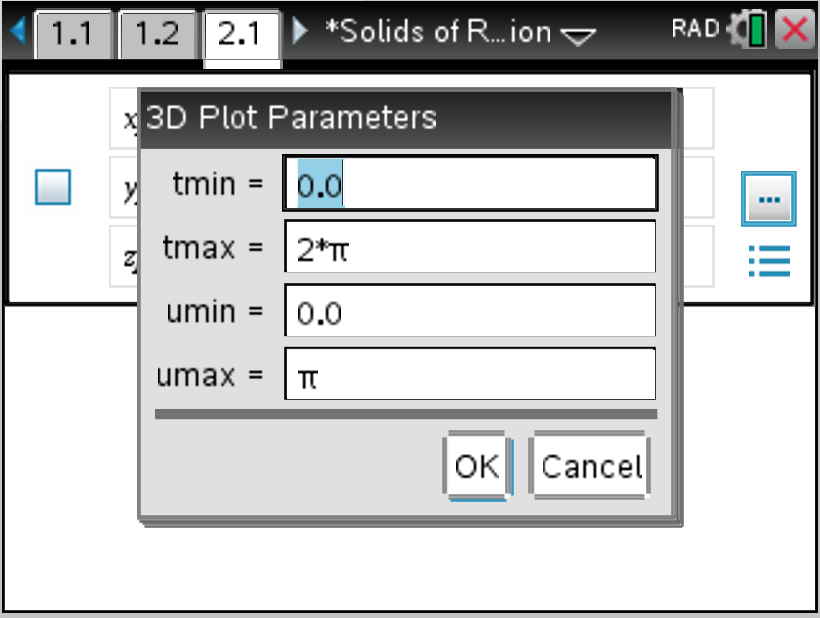
# **4. Making a Torus**

Add a new GRAPHS page, change the view to 3D, and change the GRAPH ENTRY/EDIT to PARAMETRIC.

Enter the parametric equations as shown. This will graph a circle of radius 2 in the xy-plane, centered at (0,3,0).

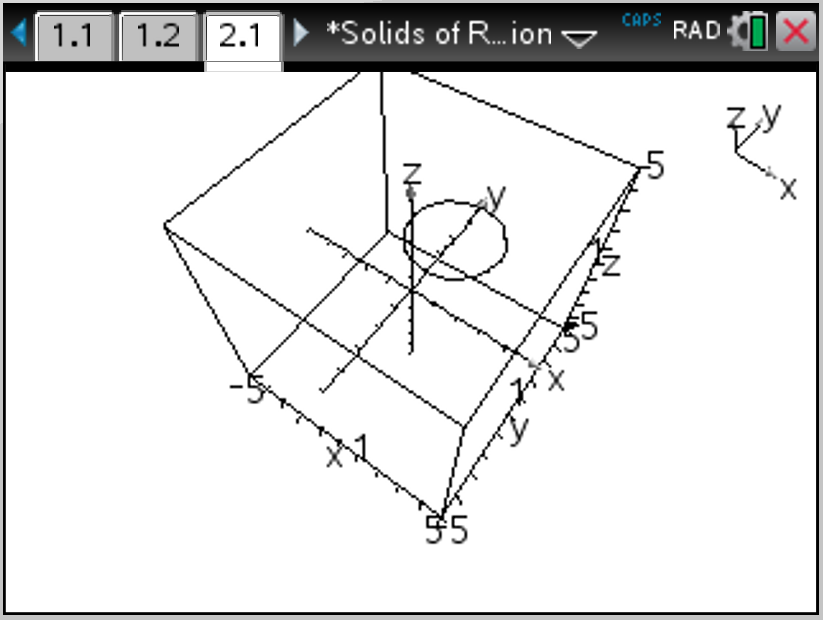


Leave the parameters settings as the default

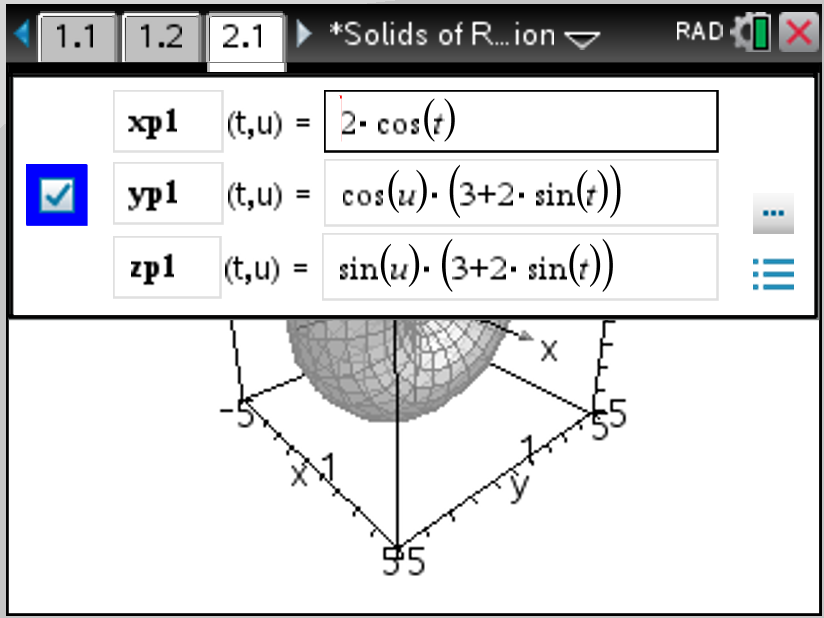


The result.

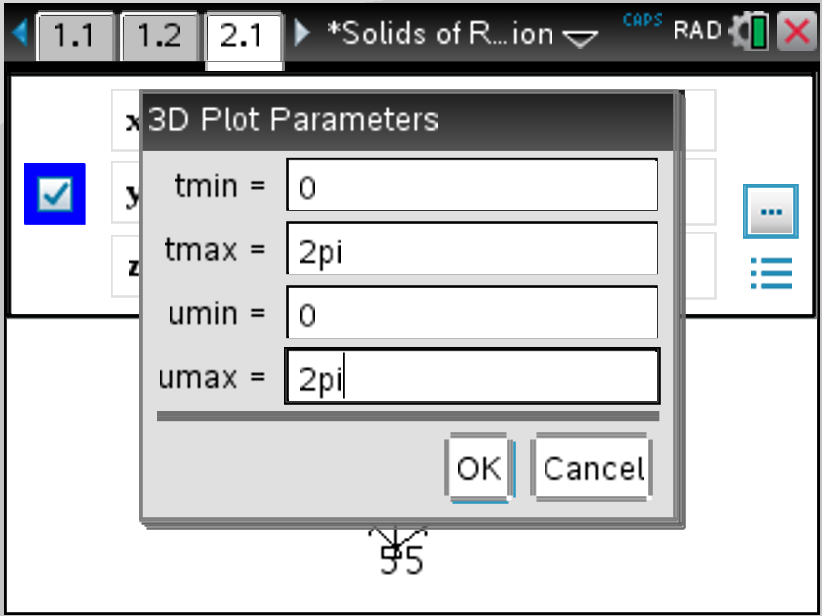
Next, to rotate this circle around the x-axis.



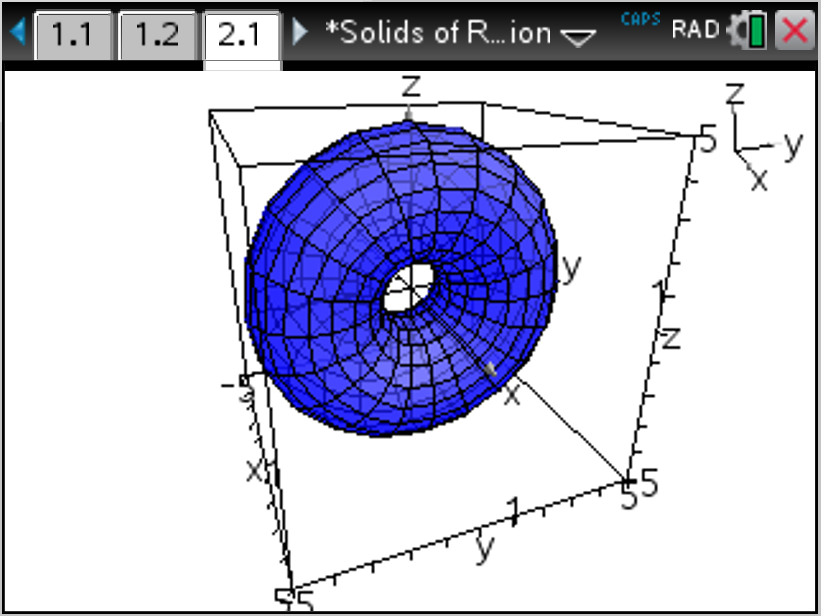
Go back to the equations that created the circle and modify them as below



Edit the parameters as below.



The result.



# 

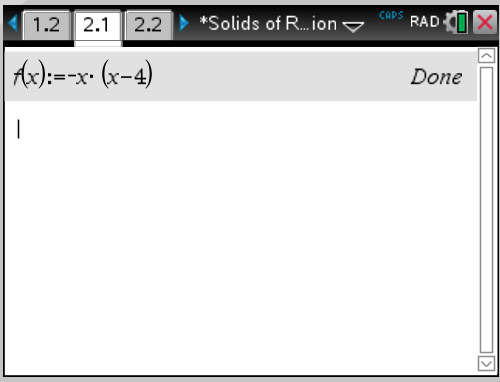
# **5. Solids of Rotation Around x-Axis.**

One of the most difficult things to visualize in Calculus are the solids of revolution. There is a simple pattern to rendering these in the 3D Graphing View on the Nspire.

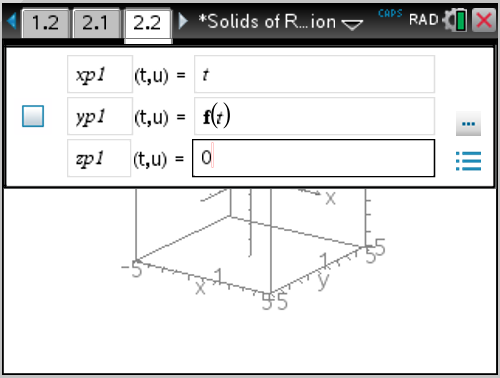
Begin by creating a new document and adding a **CALCULATOR PAGE (HOME + 1 +1)**. Define the function **f(x):= -x\*(x-4)**. 

Remember to use the “assign” equal sign.

We will rotate the portion of the graph that is above the x-axis around the y-axis.

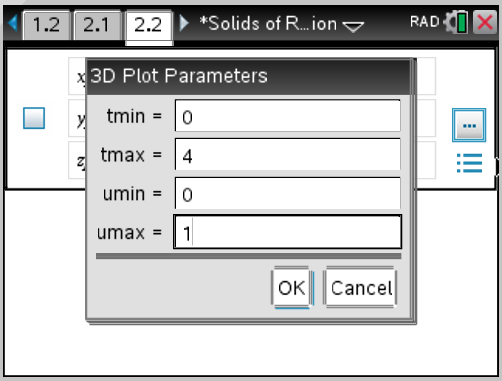


Next, add a Graphing page. Change the view to 3D, and change the Graph Entry to Parametric. Then enter the equations as shown below. This will graph the portion of f(x):=-x\*(x-4) that lies above the x-axis in the 3D view.

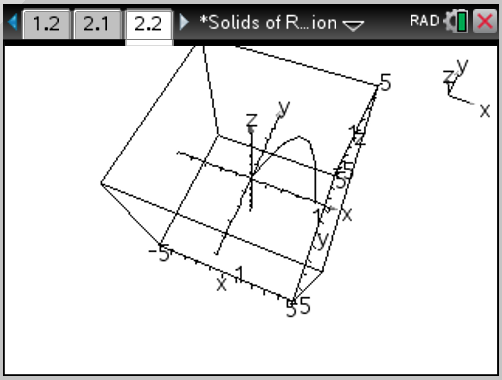


Edit the parameters so **tmin = 0** and **tmax = 4**.

The **u** parameter is not needed.



Change the orientation of the axes to get a better view.



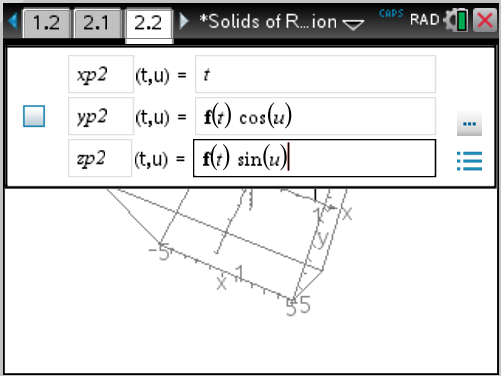
There is a **GENERAL RULE** for rotating f(x) around the x-axis:

x(t,u) = t

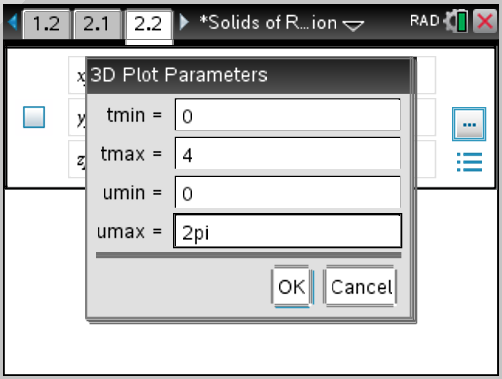
y(t,u) = f(t) cos(u)

z(t,u) = f(t) sin(u)

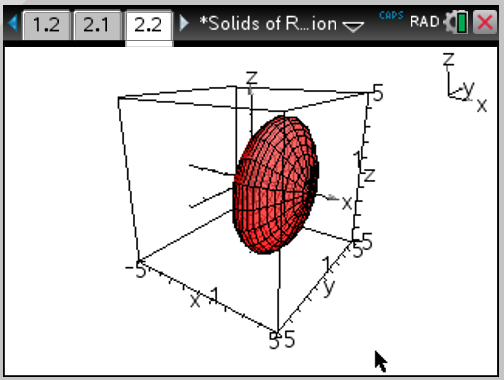
Recognizing this, you can rotate any function just by changing f(x) and (maybe) the the parameters.



Set the parameters as shown below



This is the result! Change the orientation. Look at the solid from different points of view.



Things to try:

1. Go back to the calculator page where you defined **f(x)** and change it to a different function. Take some time to explore this surface of revolution.
2. Edit the parameter **u** so the function is only rotated halfway around the x-axis, or maybe one-fourth of the way around, or maybe two-thirds the way around.
3. Explore what happens if you changed the parametric functions to be

x(t,u) = f(t) cos(u)

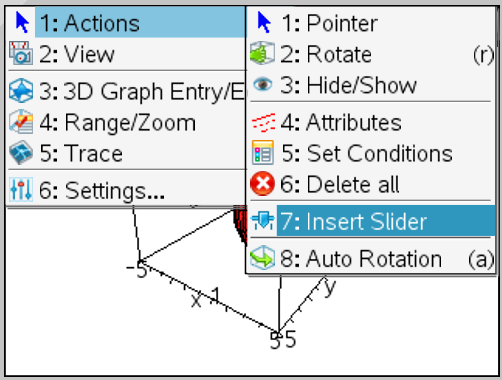
y(t,u) = t

 z(t,u) = f(t) sin(u)

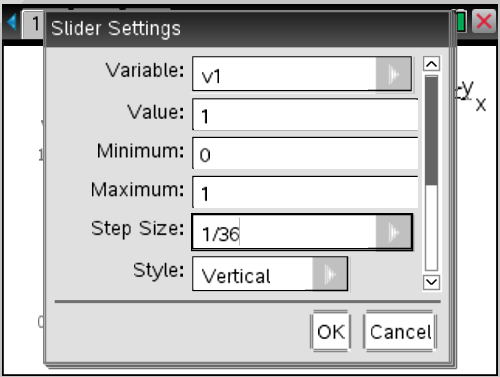
# **6. Adding a Slider**

To animate the the rotating action, we need to add a **SLIDER** to our 3D GRAPHING PAGE.

Press **MENU + 1 + 7** to insert a slider



Set the parameters of the slider as shown below.

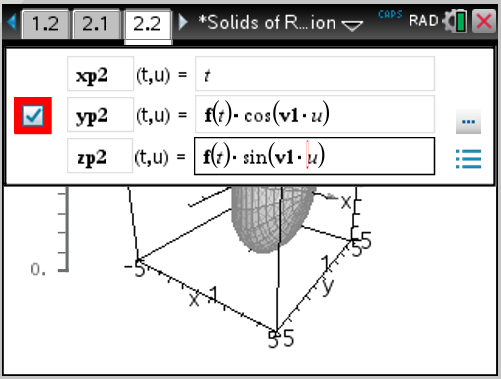


In the STEP SIZE, 1/36 will rotate the solid in units of 10 degrees.

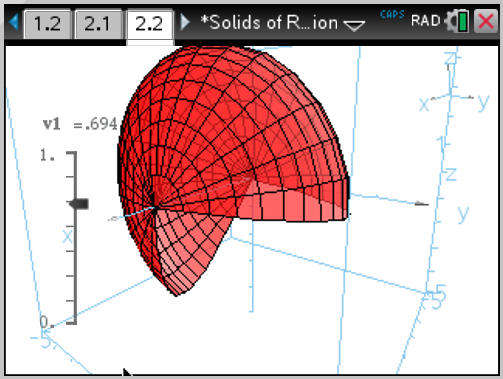
Press **CTRL + G** and **TOGGLE UP** to go back to the equations for your surface.

We want to multiply the **u** parameter by the slider value **v1** as shown below.

The parameter **u** varies from **0 through 2pi** for a complete revolution. By multiplying this parameter by **v1**, we are essentially rotating by the fraction **v1** of **2pi**.



This is the result! Explore the slider and the surface! Be sure to change the orientation!

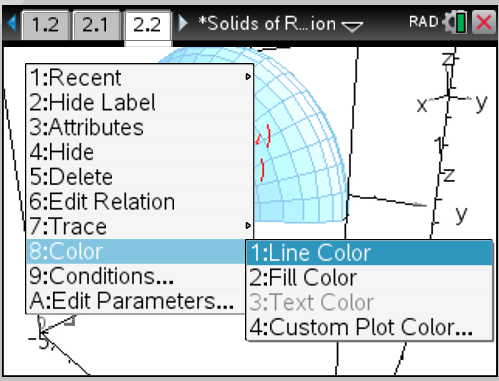


Click on the slider, then press **CTRL + MENU + 4** to animate the slider.

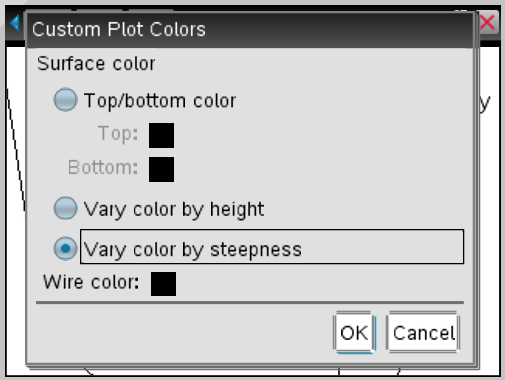
Click on the slider again and press **CTRL + MENU + 4** to stop the animation.

# **7. Adding Color**

Click on the surface so the ghost equation is visible, then press **CTRL + MENU + 8**. This is where you can go to change the colors of elements of the graph.



Explore the CUSTOM PLOT COLORS. Selecting the VARY COLOR BY STEEPNESS might be of interest to calculus teachers.



# **8. Solids of Rotation Around y-Axis.**

Another difficult thing to visualize in Calculus are the solids of revolution around the y- axis. There is a simple pattern to rendering these in the 3D Graphing View on the Nspire. We will use the same function as before.

Add a new Graphing page. Change the view to 3D, and change the Graph Entry to Parametric.

There is a GENERAL RULE for rotating f(x) around the y-axis:

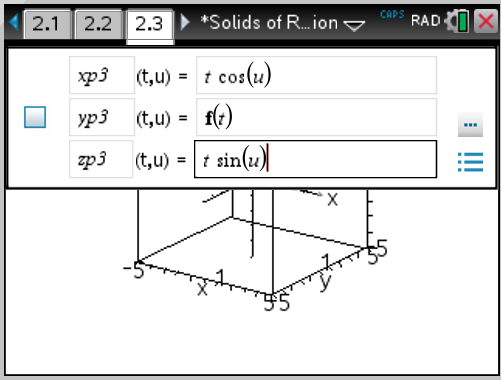
x(t,u) = t cos(u)

y(t,u) = f(t)

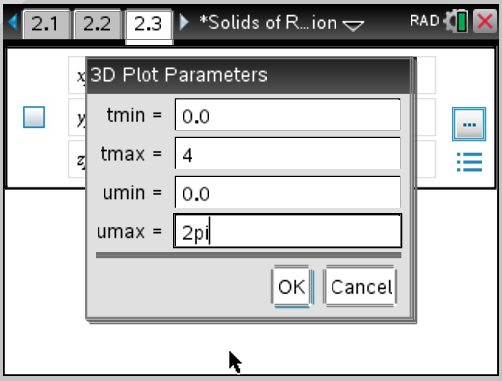
z(t,u) = t sin(u)

Recognizing this, you can rotate any function around the y-axis just by changing **f(x)** and (maybe) the the parameters.

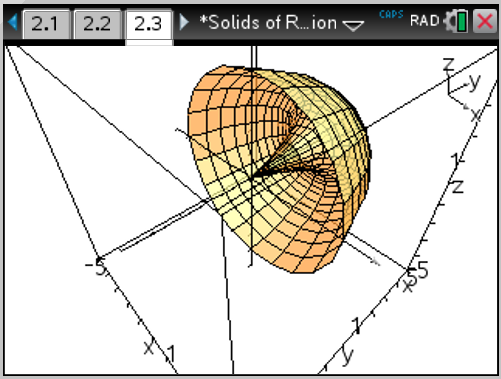
Enter the equations as shown below.



Set the parameters as show below.



This is the result!



Things to try:

* Go back to the calculator page where you defined f(x) and change it to a different function.
* Edit the parameter u so there function is only rotated halfway around the y-axis.
* Add a slider!